RETRACTABLE ROOF STRUCTURAL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/457,045, filed on March 24, 2003. The disclosure of the above application is incorporated herein by reference.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] The present invention relates generally to retractable roof vehicles, and more specifically, to retractable roof structural systems for a retractable roof vehicle. Vehicle manufacturers offering fixed roof vehicles for sale may also desire to offer a retractable roof option. These vehicles, however, may not be designed to accommodate a retractable roof system without reducing the structural rigidity or stiffness of the vehicle body. In other words, removal of the fixed roof removes a major structural element of the vehicle that enhances structural rigidity and stiffness.

[0003] To compensate for the reduced structural rigidity and stiffness when utilizing a soft-top retractable roof system on the vehicle, a fixed rear beam that extends between opposing quarter panel sections of the vehicle is employed. The fixed rear beam can be part of the boot or stowage well that is installed in the vehicle to provide a stowage space for the retractable top when in its stowed position or be independent of the stowage well. This fixed rear beam

can also serve to function as a drain trough for the vehicle to capture moisture that runs downwardly along the soft-top retractable roof.

[0004] When a hard-top retractable roof system is employed on the vehicle, however, the use of a fixed rear beam that extends between opposing quarter panel sections on the vehicle may not be an option. That is, when a hard-top retractable roof system is utilized, the panels that comprise the hard-top retractable roof require a larger stowage space and retract further back in the stowage space than the roof bows and roof cover of a soft-top retractable roof. The increased space requirement for the panels of the hard-top retractable roof prevent the positioning of a fixed rear beam between the opposing quarter panel sections in a position that provides meaningful structural support to enhance the rigidity and stiffness of the vehicle. That is, because the roof panels require the large stowage space, a fixed rear beam has to be positioned further rearwardly than that used with a soft-top retractable roof. The positioning of the fixed rear beam further rearwardly reduces the contribution of the fixed rear beam to enhancing the structural rigidity and stiffness of the vehicle. To overcome this, other structural members are incorporated into the vehicle to increase the rigidity and stiffness of the vehicle. For example, the thickness of the floor pan that forms the bottom of the boot well can be increased and/or additional support members can be added below the floor pan to enhance the structural rigidity and stiffness of the vehicle. These other structural means, however, have a limited ability to meaningfully enhance the structural rigidity and stiffness of the vehicle due to their positioning in a lower portion of the vehicle.

[0005] Accordingly, it is desirable to provide a support member that is positioned in a location on the vehicle that meaningfully enhances the structural rigidity and stiffness of the vehicle without interfering with the retraction of a retractable roof. Furthermore, it is desirable for the location of the support member to remain the same regardless of the vehicle having a soft-top retractable roof system or a hard-top retractable roof system so that the enhancement of the structure rigidity and stiffness is similar for both types of retractable roofs. Moreover, it is desirable to utilize the same structural member for both a soft-top retractable roof system and a hard-top retractable roof system for the vehicle.

[0006] A retractable roof structural system according to the principles of the present invention is advantageous over traditional designs in that it provides a support member that is positioned in a location on the vehicle that meaningfully enhances the structural rigidity and stiffness of the vehicle regardless of the retractable roof being a soft-top or hard-top retractable roof. The retractable roof structural system utilizes a support member that is coupled to opposing quarter panel sections of the vehicle to provide such structural support. The support member can be selectively uncoupled from the vehicle to allow the for unimpeded retraction of the retractable roof.

[0007] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating

the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0009] Figure 1A is a fragmented perspective view of a vehicle with a retractable roof structural system according to the principles of the present invention including a hard-top retractable roof in the raised position;

[0010] Figures 1B and 1C are fragmented side elevation views of the retractable roof structural system of Figure 1A with the hard-top retractable roof in an intermediate and stowed position, respectively;

[0011] Figures 2A-C are fragmented side elevation views of the vehicle with the retractable roof structural system of Figures 1A-C with the decklid assembly in a closed, forwardly opening and rearwardly opening position, respectively;

[0012] Figure 3A is a fragmented exploded view of the structural member and retaining mechanism of the retractable roof structural system according to the principles of the present invention;

[0013] Figure 3B is a cross-sectional view of the structural member and retaining mechanism of Figure 4A along line B-B when the structural member and retaining mechanism are engaged with one another;

[0014] Figures 4A-C are fragmented side elevation views of a vehicle with a retractable roof structural system according to the principles of the present invention including a soft-top retractable roof with the retractable roof in a raised, intermediate and stowed position, respectively;

[0015] Figure 5A is an exploded fragmented view of an alternate embodiment of the structural member and retaining mechanism of the retractable roof structural system according to the principles of the present invention;

[0016] Figure 5B is a top view of the retaining mechanism of Figure 5A along line B-B; and

[0017] Figure 6 is an exploded fragmented perspective view of a second alternate embodiment of the structural member and retaining mechanism of the retractable roof structural system according to the principles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The following description of the preferred embodiment is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0019] Figures 1A-C show an exemplary automotive vehicle 20 having a retractable roof structural system, generally indicated as 22, constructed in accordance with the teachings of the present invention. System 22 includes a retractable roof, shown as a hard-top retractable roof and generally indicated as 24, operable between a raised position (Figure 1A), intermediate positions, such

as that shown in Figure 1B, and a stowed position (Figure 1C). System 22 also includes a dual acting or two-way opening decklid assembly, generally indicated as 26, that is coupled to vehicle 20. Decklid assembly 26 includes a decklid panel 27 and is operable between a first or closed position (Figures 1A and C, 2A, and 4A-C), a second or forwardly open position (Figures 1B and 2B) to allow retractable roof 24 to move between its raised and stowed positions, and a third or rearwardly open position (Figure 2C) to allow access to a storage area from a rear of vehicle 20, as described below. Decklid assembly 26 also includes a moveable structural member 28 that extends transversely across vehicle 20. Structural member 28 is selectively coupleable to vehicle 20 to significantly enhance the torsional rigidity and stiffness of vehicle 20, as described below.

[0020] Vehicle 20 is constructed with a body 30 having a passenger compartment 32 and a stowage or storage area 34 behind passenger compartment 32 within which retractable roof 24 is located when in its stowed position. Body 30 also has opposing quarter panel sections 36 which include rear wheel housings 38 and strut towers (not shown). Wheel housings 38 and the strut towers encroach into storage area 34. Passenger compartment 32 includes a windshield 40 and a header 42. Header 42 spans transversely across the top of windshield 40.

[0021] Retractable roof 24 is similar to that disclosed in U.S. Pat. App. Serial No. 10/245,973 filed on September 18, 2002, entitled "Vehicle Retractable Hard-top Roof" by Willard and assigned to the assignee of this Application, the disclosure of which is incorporated by reference herein. Retractable roof 24

includes a first roof section or panel 50, a second roof section or panel 52, a third roof section or panel 54 and a retraction mechanism 56. Retractable roof 24 is moveable from a raised position depicted in Figure 1A, through intermediate positions, such as the position depicted in Figure 1B, to a stowed position depicted in Figure 1C. Each of the first, second and third roof sections are substantially rigid members interconnected to one another by retraction mechanism 56.

[0022] First roof section 50 has an outer surface 60, an inner surface 62, a leading edge 64, and a trailing edge 66. First roof section 50 includes a conventional latching mechanism (not shown) which is disengageably attachable with header 42 when retractable roof 24 is in the raised position. Leading edge 64 sealingly engages header 42 when the latching mechanism secures first roof section 50 to header 42.

[0023] Second roof section 52 has an outer surface 68, an inner surface 70, a leading edge 72, and a trailing edge 74. Leading edge 72 sealingly engages trailing edge 66 of first roof section 50 when retractable roof 24 is in the raised position. Third roof section 54 has an outer surface 76, an inner surface 78, a leading edge 80, and a trailing edge 82. Leading edge 80 is sealingly engaged with trailing edge 74 of second roof section 52 when retractable roof 24 is in the raised position. Trailing edge 82 includes lip seals (not shown) which sealingly engage decklid panel 27 when third roof section 54 is in the raised position. Third roof section 54 also includes includes a transparent window 83. Window 83 may be a three-dimensionally curved glass member matching the

contour of the rear portion of third roof section 54 or may be a flexible translucent panel constructed from PVC or other suitable material.

[0024] Retraction mechanism 56 is mounted in a cavity of storage area 34. Retraction mechanism 56 includes a pair of actuation assemblies 86 that are mounted to fixed brackets 88 near each outboard edge of vehicle 20. Because each of actuation assemblies 86 are substantially identical mirror images of one another, only the driver's side actuation assembly will be described in greater detail.

[0025] Actuation assembly 86 includes a first linkage assembly 90 that interconnects third roof section 54 with bracket 88. A second linkage assembly 92 interconnects first and second roof sections 50, 52 together and interconnects roof sections 50, 52 with bracket 88. An actuator 94 is coupled to first linkage assembly 90 and is operable to cause retractable roof 24 to move between its raised and stowed positions, as described below. Actuator 94 is depicted as a hydraulic cylinder coupled to first linkage assembly 90. It should be appreciated, however, that actuator 94 may alternately be constructed as an electric motor, a pneumatic cylinder, or any suitable power source for driving first linkage assembly 90. Actuator 94 is coupled to vehicle 20 and positioned within the cavity of storage area 34.

[0026] First and second linkage assemblies 90 and 92 are interconnected by a control link 96 so that movement of second and third roof sections 52 and 54 between the raised and stowed positions is coordinated. First and second roof sections 50 and 52 are interconnected together adjacent

their respective trailing edge 66 and leading edge 72 at pivot 98. Alternately, a hinge assembly (not shown) that may include a pair of clasps (not shown) coupled to first and second roof sections 50 and 52 that are each pivotably coupled to one another by a hinge pin (not shown) can be used. Pivot 98 coordinates the movement of first and second roof sections 50 and 52 relative to one another and causes first and second roof sections 50 and 52 to retract in a clamshell type manner, as described below. A control mechanism (not shown) capable of sensing the positions of roof sections 50, 52 and 54 and/or that of retraction mechanism 56 is used to assure that retractable roof 24 may be moved between the raised and stowed positions without causing binding or interferences between the roof sections, decklid assembly 26 and any other vehicle components. With reference to Figure 1C, retractable roof 24 is shown in the stowed position. In the stowed position, first roof section 50 and second roof section 52 are each positioned in a substantially horizontal manner within storage area 34.

[0027] Referring now to Figures 2A-C, details of decklid assembly 26 are shown. Decklid assembly 26 includes a frame 104, rear linkage assemblies 106, decklid panel 27, and front linkage assemblies 108. Frame 104 includes two longitudinal members 110 along with a rear transverse member 112 and structural member 28 that space longitudinal members 110 apart and are attached to respective rear and front portions of longitudinal members 110. Structural member 28 moves with the movement of frame 104. Structural member 28 engages with retaining mechanisms 113 that are fixedly attached to

vehicle 20 in storage area 34 between quarter panels 36. The engagement of structural member 28 with retaining mechanisms 113 secures structural member 28 to the body 30 of vehicle 20 to provide significant structural support and torsional rigidity to vehicle 20. The interaction between structural member 28 and retaining mechanisms 113 is described in more detail below.

[0028] A front portion of decklid panel 27 is pivotably coupled to a front portion of frame 104 by front linkage assemblies 108. Front linkage assemblies 108 allow decklid panel 27 to move between the rear open and closed positions to allow access to storage area 34 independent of movement of frame 104, as described below. Rear linkage assemblies 106 are attached to a rear portion of frame 104 and to fixed brackets 114 on vehicle 20. Rear linkage assemblies 106 are operable to cause frame 104 and decklid panel 27 to move between the forward open and the closed positions to allow retraction and extension of retractable roof 24, as described below. Powered actuators 116 are attached to a rear portion of storage area 34 and to one of the links in each rear linkage assembly 106. Powered actuators 116 are operable to move rear linkage assemblies 106 and cause frame 104 and decklid panel 27 to move between the forward open and closed positions. Powered actuators 116 can take a variety of forms. Preferably, powered actuators 116 are hydraulic cylinders that move between extended and retracted positions to operate rear linkage assemblies 106. Alternatively, powered actuators 116 can be in the form of electric motors that drives rear linkage assemblies 106.

[0029] Figures 2A and 2B illustrate rear linkage assembly 106 which includes a first link 118 that fixedly attaches rear linkage assembly 106 to bracket 114 of vehicle 20. First link 118 thereby is a fixed link that remains stationary regardless of movement of rear linkage assembly 106. One end of a second link 120 is pivotably attached to first link 118 at pivot 122 while the other end of second link 120 is pivotably attached to a rear portion of longitudinal member 110 of frame 104 at pivot 124. One end of a third link 126 is pivotably attached to a rear portion of longitudinal member 110 of frame 104 at pivot 128 while the other end of third link 126 is pivotably attached to first link 118 at pivot 130. Thus, rear linkage assembly 106 forms a four-bar non-scissor linkage assembly which includes first link 118, second link 120, longitudinal member 110, and third link 126 and is defined by pivots 122, 124, 128 and 130.

[0030] One end of powered actuator 116 is pivotally attached to second link 120 at pivot 132 while the other end of powered actuator 116 is attached to body 30 of vehicle 20. As shown in Figure 2A, when powered actuator 116 is in a retracted position, frame 104 is in its closed position, decklid panel 27 covers a portion of storage area 34, and structural member 28 is engaged with retaining mechanisms 113. To move decklid panel 27 from the closed position to the forward open position, retaining mechanisms 113 are operated to release structural member 28, and powered actuator 116 is operated to move from its retracted position to its extended position, as shown in Figure 2B. As powered actuator 116 extends, second link 120 is pushed by powered actuator 116 and causes frame 104 and decklid panel 27 to move to the forward

open position. When frame 104 is in the forward open position, decklid panel 27 is no longer covering storage area 34, structural member 28 is not extending between quarter panels 36 in storage area 34 and retractable roof 24 can be operated to move between its raised and stowed positions. It is preferred that decklid panel 27 remain in its closed position when frame 104 is moved between the forward open and closed positions. Once retractable roof 24 has been moved to its raised or stowed position, powered actuator 116 is operated to retract and pull second link 120 toward powered actuator 116. The retraction of powered actuator 116 thereby causes frame 104 and decklid panel 27 to move from the forward open position to the closed position. Structural member 28 can then engage with retaining mechanisms 113 to provide significant torsional rigidity and stiffness to vehicle 20. Thus, powered actuator 116 either pushes or pulls second link 120 away from or toward powered actuator 116 to cause frame 104, decklid panel 27 and structural member 28 to move and allow access to storage area 34 so that retractable roof 24 can move between the raised and stowed positions.

[0031] Referring now to Figures 2A and 2C, it can be seen that front linkage assembly 108 is operable to allow decklid panel 27 to move between its closed position, as shown in Figure 2A, and its rear open position, as shown in Figure 2C, which allows access to storage area 34 from a rear of vehicle 20. Front linkage assembly 108 includes a first link 138 which is fixedly attached to a front portion of decklid panel 27. One end of a second link 140 is pivotably attached to first link 138 at pivot 142 while the other end of second link 140 is

pivotably attached to a front portion of longitudinal member 110 of frame 104 at pivot 144. One end of a third link 146 is pivotably attached to the front portion of longitudinal member 110 at pivot 148 further forward of pivot 144 while the other end of third link 146 is pivotably attached to first link 138 at pivot 150. First link 138, second link 140, longitudinal member 110, and third link 146 thereby form a four-bar linkage assembly defined by pivots 142, 144, 148 and 150 which allows decklid panel 27 to move between the rear open and the closed positions. A biasing member 152, in this case in the form of gas strut, is attached to longitudinal member 110 and first link 138. Gas strut 152 helps retain decklid panel 27 in the rear open position. Alternatively, other biasing mechanisms can be used, such as springs, without departing from the scope of the present invention. Decklid panel 27 is capable of moving between the rear open and closed positions independently of movement of frame 104. Thus, frame 104 can remain stationary and/or in its closed position while decklid panel 27 moves between the rear open and closed positions.

[0032] Structural member 28 is fixedly attached, such as by welding, bolts or the like, to longitudinal members 110 and extends transversely through storage area 34 between quarter panel sections 36. Structural member 28 has opposite ends that are each received within retaining mechanisms 113 which are fixedly attached to opposing quarter panel sections 36 of body 30 of vehicle 20. Retaining mechanisms 113 are operable to selectively engage and disengage with structural member 28. When retaining mechanisms 113 are engaged with structural member 28, structural member 28 becomes an integral part of body 30

of vehicle 20 and provides significant structural support and torsional rigidity to body 30 between opposing quarter panel sections 36. That is, structural member 28 forms a rigid connection between opposing quarter panel sections 36 that functions to structurally reinforce and stiffen body 30 of vehicle 20 so that a desired torsional rigidity and stiffness of vehicle 20 is achieved. Typically, the resulting location will be in the upper portion of storage area 34 above the floor pan of storage area 34. This upward location within storage area 34 facilitates the enhancing of the structural rigidity and stiffness of body 30 of vehicle 20. The location of structural member 28 when secured by retaining mechanisms 113 in that area may interfere with movement of retractable roof 24 between its raised and stowed positions. To accommodate the desire to provide additional structural support and rigidity to the upper portion of storage area 34 while enabling the use of a retractable roof 24, structural member 28 moves with the movement of frame 104 of decklid assembly 26 to allow access to storage area 34 and to not interfere with the movement of retractable roof 24 between its raised and stowed positions, as described below. Structural member 28 serves essentially the same function as the fixed rear beam that is used on traditional soft-top retractable roof vehicles to enhance the structural rigidity and stiffness of the vehicle.

[0033] Referring now to Figures 3A and B, the preferred embodiment of structural member 28 and retaining mechanisms 113 is shown. An engagement member 158 is attached to the end of structural member 28. Engagement member 158 can be attached to the end of structural member 28 in

a variety of ways. For example, engagement member 158 can be attached with welding, bolts or the like. Engagement member 158 is configured to engage with retaining mechanism 113 to secure structural member 28 to quarter panel sections 36 of vehicle 20. Engagement member 158 has a guide and force transmitting pin 160 that extends outwardly therefrom. A latching member, in this case in the form of a striker, also extends outwardly from engagement member 158. Retaining mechanism 113 has a recess 164 that is complementary to pin 160. Preferably, pin 160 is conical in shape or tapers towards its tip and recess 164 is a complementary conical or tapered recess. The complementary tapering of pin 160 and recess 164 align structural member 28 relative to retaining mechanism 113 when engaging structural member 28 with retaining mechanism 113.

[0034] Retaining mechanism 113 also has a latching member 166 that engages with striker 162 and the opening therein to secure structural member 28 to retaining mechanisms 113. In the preferred embodiment, latching member 166 is in the form of a hooked-shaped member that when struck by striker 162 moves to engage with the opening in striker 162 to secure structural member 28 to retaining mechanism 113. Latching member 166 is preferably a power pull-down latching member wherein the contact between striker 162 and latching member 166 causes latching member 166 to latch onto striker 162 and pull structural member 28 toward retaining mechanism 113 as guided by the engagement between pin 160 and recess 164. The power pull-down latching member continues to pull structure member 28 toward retaining mechanism 113

until a desired relative position is achieved. Preferably, during this period, the powered actuator 116 is controlled to be in a relaxed or non-biasing state to allow frame 104 to be pulled downwardly along with structural member 28 by the power pull-down latching member.

[0035] The engagement between pin 160 and recess 164, along with providing an alignment function, is also the force transmitting coupling between structural member 28 and quarter panel sections 36 via retaining mechanisms 113. That is, as vehicle 20 is driven the flexing and twisting of body 30 is transmitted between opposing quarter panel sections 36 through retaining mechanisms 113 and structural member 28. Accordingly, pin 160 and recess 164 are designed to accommodate the expected compression and tension to be imparted therebetween due to the operation of vehicle 20. Preferably, structural member 28, engagement member 158, and recess 164 are all made of a strong metal, such as steel or the like, to facilitate the transmitting of these forces without failing. It should be appreciated, however, that other materials capable of withstanding the expected stresses and strains can be utilized. Furthermore, striker 162 and latching member 166 are preferably designed so that the forces being transferred between opposing quarter panel sections 36 through structural member 28 do not impose significant loading on striker 162 and latching member 166.

[0036] As shown in Figures 2A-C, structural member 28 is rectangular in cross-sectional shape. It should be appreciated, however, that other cross-sectional shapes, such as circular, can be employed. The cross-sectional shape

selected for structural member 28 will depend upon the space available and the force- transmitting characteristics for the specific shape.

[0037] Structural member 28, being a force transmitting member, is made from a strong material, such as metal. A variety of materials can be used to make structural member 28. For example, structural member 28 can be made from a standard sheet steel section that is folded and welded into the desired cross-sectional shape.

[0038] Decklid assembly 26 is preferably operated by a separate control system (not shown) capable of moving decklid assembly 26 between the rear open, closed, and forward open positions. The control system functions to coordinate movement of decklid assembly 26 with retractable roof 24 such that storage area 34 is accessible when moving retractable roof 24 between its raised and stowed positions. Alternately, decklid assembly 26 may be manually operated and selectively latched to body 30. As such, storage area 34 is selectively enclosed or accessible. The manually operated decklid assembly 26 includes a biasing mechanism, such as a spring (not shown), for urging decklid assembly 26 toward the forward open position.

[0039] In operation, retractable roof 24 is moved from the raised position depicted in Figure 1A through intermediate positions such as the one depicted in Figure 1B, to the stowed position depicted in Figure 1C by first unlatching first roof section 50 from header 42. An operator engages a switch (not shown) located in passenger compartment 32. The switch is connected electrically to actuator 94 to control the operation of retractable roof 24. When

retractable roof 24 is used in conjunction with a manually operated decklid, a simple switch may be implemented without the need for sophisticated electronic controls, proximity switches and/or sensors. However, the retractable roof of the present invention may be operated in conjunction with a power operated decklid as previously discussed. In this case, the switch is connected electrically to an electronic control unit (not shown) such as a microprocessor, that controls the operation of retractable roof 24. The electronic control unit sends a signal to operate actuator 94, retaining mechanisms 113 and actuators 116 coupled to decklid assembly 26. Devices such as limit switches, sensors and/or potentiometers are coupled to body 30, decklid assembly 26 and retractable roof 24 to inform the electronic control unit of the position of decklid assembly 26 and retractable roof 24 to assure that retractable roof 24 and decklid assembly 26 do not interfere with one another during movement between the stowed and raised positions. An example of a suitable control system for retractable roof 24 and/or decklid assembly 26 is that disclosed in U.S. Patent No. 6,288,511 entitled "Automotive Convertible Top System" issued to Porter et al., the disclosure of which is incorporated by reference herein.

[0040] When the operator engages the switch to operate retractable roof 24, the control system causes retaining mechanisms 113 to disengage from or release structural member 28 and decklid panel 27 to move from its closed position to its forward open position to allow access to storage area 34 for the movement of retractable roof 24. As decklid panel 27 and frame 104 move from the closed position to the forward open position, structural member 28

disengages from retaining mechanisms 113. The disengagement of structural member 28 from retaining mechanisms 113 uncouples structural member 28 from opposing quarter panel sections 36 of body 30 of vehicle 20. With structural member 28 disengaged from retaining mechanisms 113, structural member 28 travels with frame 104 and decklid panel 27 to the forward open position, as shown in Figure 1B.

[0041] Actuator 94 is pivotably coupled to and powered to drive first linkage assembly 90 to move retractable roof 24 between the raised and stowed positions. As first linkage assembly 90 articulates, force is transferred through control link 96 to second linkage assembly 92 and to first and second roof sections 50, 52. The force produced is sufficient to cause first, second and third roof sections 50, 52, and 54 to move. As depicted in Figure 1B, first roof section 50 pivots relative to second roof section 52 in a clamshell manner such that inner surface 62 of first roof section 50 approaches inner surface 70 of second roof section 52. Thus, when moving from the raised to the stowed position, second roof section 52 rotates rearwardly, first roof section 50 rotates counterclockwise (in the view depicted) relative to second roof section 52, and third roof section 54 rotates rearwardly. Once retractable roof 24 is fully retracted, frame 104 and decklid panel 27 can be moved to the closed position, as shown in Figure 1C.

[0042] As decklid assembly 26 moves from the forward open position to the closed position structural member 28 engages with retaining mechanisms 113 and effectively couples opposing quarter panel sections 36 to structural member 28. This coupling enables loads to be transferred between opposing

quarter panel sections 36 via structural member 28 which functions to increase the torsional rigidity and stiffness of body 30 of vehicle 20. Structural member 28 is configured so that when structural member 28 is engaged with retaining mechanisms 113 and retractable roof 24 is in the stowed position, structural member 28 does not contact outer surface 60 of first roof section 50. In other words, structural member 28 is configured so that retractable roof 24, when in the stowed position, does not interfere with the engagement of structural member 28 with retaining mechanisms 113. As such, structural member 28 can take a variety of shapes and configurations depending on the shape and configuration of retractable roof 24, storage area 34 and the locations of retaining mechanisms 113. For example, structural member 28 can be generally U-shaped so that the end portions extend downwardly and engage with retaining mechanisms 113 while an intermediate portion extends over outer surface 60 of first roof section 50 when retractable roof 24 is in the stowed position. Structural member 28 could also be substantially straight and extend directly across storage area 34, if the configuration of retractable roof 24 so allowed.

[0043] Retractable roof structural system 22, according to the principles of the present invention, can also be utilized with a soft-top retractable roof, such as that discussed below. System 22 when used with a soft-top retractable roof enables structural member 28 to be positioned more forwardly in storage area 34 than is possible with the fixed rear beam that is used with a traditional soft-top retractable roof. That is, structural member 28 can be positioned more forwardly in the vehicle such that structural member 28 extends

between opposing quarter panel sections 36 beneath the rearmost roof bow of the soft-top retractable roof without interfering with the retraction of the retractable roof due to structural member 28 moving with decklid assembly 26 to allow access to storage area 34 when retracting the retractable roof. Thus, system 22 provides more flexibility in the positioning of a structural member to enhance the torsional rigidity and stiffness of a vehicle on which a soft-top retractable roof is employed.

[0044] System 22 when used with a soft-top retractable roof, also enables the use of a bootwell that is not required to provide structural enhancement to the rigidity or stiffness of vehicle 20. That is, vehicle 20 can utilize system 22 and, specifically, structural member 28 to provide the desired enhancement to the torsional rigidity and stiffness of vehicle 20 between opposing quarter panel sections 36 while the bootwell serves to provide the desired stowage space for the retractable roof and drain water through appropriate troughs. With this functionality, the bootwell can be economically manufactured from a plastic material instead of the expensive sheet metal or steel that is currently used.

[0045] Referring now to Figures 4A-C, retractable roof structural system 22 is shown on vehicle 20 having a soft-top retractable roof 24'. Soft-top retractable roof 24' includes a linkage assembly or top stack mechanism 180 covered by a pliable fabric top covering 182. More specifically, the linkage assembly includes a number one or forwardmost roof bow 184, a number two roof bow 186, a number three roof bow 188, a number four roof bow 190, and a

number five or rearmost roof bow 192. The top stack mechanism 180 also includes a front roof rail 194, a center roof rail 196, and a rear roof rail 198 (shown in Figure 4C).

[0046] As can be seen in Figure 4C, front roof rail 194 is pivotably coupled to center roof rail 196 and is controlled by a linkage assembly. Center roof rail 196 is pivotably coupled to rear roof rail 198 and is controlled by a different linkage assembly. Soft-top retractable roof 24' is operable to move between a raised or extended position covering passenger compartment 32, as shown in Figure 4A, through intermediate positions, such as that shown in Figure 4B, to a fully retracted or stowed position within storage area 34, as shown in Figure 4C. An actuator (not shown), such as a hydraulic cylinder, is coupled to top stack mechanism 180 to move retractable roof 24' between its raised and stowed positions. It should be appreciated that the type of actuator used can vary and can include a hydraulic cylinder, an electric motor, a pneumatic cylinder, or any other suitable power source for driving top stack mechanism 180. Preferably, the actuator used is the same type of actuator that is used with decklid assembly 26. Alternatively, retractable roof 24' can be manually operated to move between the raised and stowed positions.

[0047] In operation, when it is desired to move retractable roof 24' from the raised position to the stowed position, number five roof bow 192 is rotated upwardly and forwardly, as shown in Figure 4B, an amount sufficient to allow frame 104 of decklid assembly 26 to be moved from the closed to the forward open position. Once number five roof bow 192 has moved a sufficient distance,

decklid assembly 26 is operated to cause frame 104 to move from the closed to the forward open position to allow access to storage area 34. Soft-top retractable roof 24' is then retracted into storage area 34, as shown in Figure 4C. As can be seen, the roof rails 194, 196 and 198 rotate relative to one another and are stacked on top of one another when in the stowed position. Decklid assembly 26 is then operated to cause frame 104 to move to the closed position thereby causing decklid panel 27 to cover at least a portion of soft-top retractable roof 24'. While soft-top retractable roof 24' is disclosed as being an automatically operated soft-top retractable roof, it should be appreciated that movement of soft-top retractable roof 24' between its extended and stowed positions can be done manually without the use of powered actuators.

[0048] It should be appreciated that system 22 according to the principles of the present invention enables storage area 34 of vehicle 20 to be designed to be universally configured to accept either a hard-top retractable roof or a soft-top retractable roof, regardless of the existence of a decklid that extends beneath the soft-top retractable roof. That is, not all soft-top retractable roofs have a roof bow that extends over the exterior surface of a decklid such that a structural member that is positioned beneath the decklid must be removed so that the soft-top retractable roof can be retracted. With system 22 of the present invention the location of structural member 28 can be chosen to provide a desired enhancement of the torsional rigidity and stiffness of vehicle 20. This same location can be utilized for both a soft-top retractable roof and a hard-top retractable roof. When using a soft-top retractable roof, this location can be

utilized as the rear lip or drain trough of the bootwell that is installed in storage area 34. Thus, the rear lip of the bootwell can be coupled to the opposing quarter panel sections 36 at this desired location without interfering with the operation of the soft-top retractable roof. The same location can then be used for a hard-top retractable roof. This is accomplished by positioning structural member 28 beneath decklid panel 27 in a position that corresponds to the desired location of coupling opposing quarter panel sections 36. Because structural member 28 is selectively coupled to opposing quarter panel sections 36, structural member 28 can be moved with the operation of decklid assembly 26, as discussed above, to not interfere with the operation of the hard-top retractable roof between its raised and stowed positions. This functionality enables vehicle 20 using the retractable roof structural system of the present invention to be converted to either a soft-top or hard-top retractable roof that utilizes a structural member 28 that couples to opposing quarter panel sections 36 at the same or common location regardless of the type of retractable roof utilized. System 22 also enables a vehicle 20, when it is being designed, to select a preferred location for coupling of opposing quarter panel sections 36 together with a structural member regardless of the type of retractable roof that will be employed. This functionality can reduce the design costs for vehicle 20 while providing similar performance characteristics for vehicle 20 regardless of the use of a soft-top or hard-top retractable roof.

[0049] Referring now to Figures 5A and B, a first alternate embodiment of structural member 28 of system 22 is shown. In this embodiment, retaining

mechanisms 113' have a sloped surface 202 that engages with a complementary sloped surface 204 on engagement members 158' of structural member 28'. The sloped surfaces 202, 204 engage with one another as frame 104 moves to its closed position. Engagement between sloped surfaces 202, 204 pushes on structural member 28' and aligns structural member 28' with retaining mechanisms 113' in the cross-car direction. Guide pins 160' and recesses 164' can then be designed to provide fore and aft alignment of structural member 28' with retaining mechanisms 113'. Strikers 162' engage with latching members 166' to pull structural member 28' into secure engagement with retaining mechanisms 113'. Guide pins 160' and recesses 164' allow force to be transmitted between opposing quarter panels 36 through structural member 28' to enhance the torsional rigidity and stiffness of vehicle 20.

[0050] In yet another alternate embodiment, as shown in Figure 6, retaining mechanisms 113" include a clamping member 210 that engages with an annular recess 212 on the ends of structural member 28" to selectively secure structural member 28" to opposing quarter panels of vehicle 20. Clamping members 210 preferably have a tapered surface that is complementary to a tapered surface on annular recesses 212 to facilitate the alignment of an engagement between retaining mechanisms 113" and structural member 28". Retaining mechanisms 113" also have a support 214 that is complementary to annular recesses 212 and upon which annular recesses 212 of structural member 28' are positioned when secured to retaining mechanisms 113". In this embodiment, force is transferred between the opposing quarter panels through

structural member 28" via the engagement between annular recesses 212 and supports 214 of retaining mechanisms 113". Clamping member 210 is operable to selectively engage and disengage with structural member 28" to allow frame 104 and decklid panel 27 to move between the closed and forward open positions.

[0051] It should be appreciated that while system 22 is shown as including specific retractable roofs 24, 24', other retractable roofs can be employed without departing from the spirit and scope of the invention. Additionally, system 22 can be utilized with an outfolding convertible roof such as that disclosed in U.S. Patent No. 4,828,317 entitled "Convertible Top Frame with Quarter Windows" by Muscat, the disclosure of which is incorporated by reference herein. Furthermore, system 22 can also be used with different types of decklid assemblies both power operated and manually operated. Additionally, structural member 28 may be attached to decklid panel 27 in addition to or instead of frame 104, if desired.

[0052] Thus, it should be appreciated that retractable roof structural system 22 according to the principles of the present invention provides many advantages and features for a vehicle 20 that heretofore have not been available. System 22 allows the placement of structural member 28 in a location on vehicle 20 that provides meaningful enhancement of the torsional rigidity and stiffness of vehicle 20. Such a location is achieved by the ability of structural member 28 to be moved, in conjunction with decklid assembly 26, out of storage area 34 to provide unimpeded access to storage area 34 for the movement of a retractable

roof between its raised and stowed positions. System 22 enables such enhancement of the torsional rigidity and stiffness of vehicle 20 regardless of the use of a hard-top or soft-top retractable roof.

[0053] The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.